Technical Report 877

O5H (Morse Intercept Operator) Performance: An Exploratory Study

Beverly G. Knapp and Frances L. Carter
U.S. Army Research Institute

Richard A. Hagerdon
U.S. Army Intelligence School, Fort Devens

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EDGAR M. JOHNSON
Technical Director

JON W. BLADES
COL, IN
Commanding

Technical review by

Gregory M. Kreiger
George W. Lawton

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This project was designed to help the U.S. Army Intelligence Center and School (USAICS) identify and measure the characteristics of successful Morse Intercept Operators (MOS 05H) in order to improve personnel utilization and performance. Characteristics of operators were identified and standardized tests matched to the characteristics. Tests were given to field and student samples and related to performance on available criteria.

The new test measures were powerful in predicting field performance but less so in determining academic performance. Learning rate was better predicted than course attrition. It is suggested that follow-on efforts be directed to attrition rather than new measures validation.

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Beverly G. Knapp and Frances L. Carter
U.S. Army Research Institute

Richard A. Hagerdon
U.S. Army Intelligence School, Fort Devens

Field Unit at Fort Huachuca, Arizona
Julie A. Hopson, Chief

Systems Research Laboratory
Robin L. Keesee, Director

U.S. Army Research Institute for the Behavioral and Social Sciences
5001 Eisenhower Avenue, Alexandria, Virginia 22333-5600

Office, Deputy Chief of Staff for Personnel
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Operational Effectiveness

FOREWORD

The Fort Huachuca Field Unit of the U.S. Army Research Institute for the Behavioral and Social Sciences performs research and development activity directly supporting the U.S. Army Intelligence Center and Schools (USAICS) and the Military Intelligence (MI) community. A continuing concern of the Army MI community is the identification and measurement of the soldier skills for appropriate training and system assignment. Because the high cost of training and extensive course length of the majority of MI MOS (Military Occupational Specialties), it is critical to match soldiers to skill training bases and jobs.

This report provides important data relating to MI MOS 05H (Morse Intercept Operator) and the difficulty in identifying successful performers in this strategic collector position. Since the Army Intelligence School at Fort Devens has recently taken responsibility for servicewide training of all Morse collectors, it has become crucial to understand the factors that contribute to success in this position. The performance data from this effort, provided directly to the command group at USAICS, have indicated the direction to be taken in order to sustain and enhance Morse operator efficiency.

EDGAR M. JOHNSON
Technical Director

05H (MORSE INTERCEPT OPERATOR) PERFORMANCE: AN EXPLORATORY STUDY

EXECUTIVE SUMMARY

Requirement:

To identify performance related factors that can be used to establish new training and candidate screening procedures of Morse Intercept Operators (MOS 05H) in order to reduce Advanced Individual Training (AIT) attrition.

Procedure:

Characteristics of successful Morse intercept operators were elicited in focus group sessions with subject matter expert personnel. Following this, the identified characteristics were matched to existing standardized test instruments that appeared to measure the elicited Morse task factors. These test instruments were administered to Morse operators at three field sites as well as to incoming AIT students at the U.S. Army Intelligence School, Fort Devens. Regression analyses were performed to identify those factors that were predictive of field and training performance. For the operators, recent SQT scores served as the criterion, and for the student group, learning rate and academic attrition.

Findings:

The matching process of elicited Morse task characteristics to standardized test measures resulted in a test instrument that was predictive of individuals who will succeed on the job, but not predictive of AIT attrition. The test measures accounted for 29% of variance in the operator group but only 11% in the student group for criterion performance. When combined with existing selection standards (ASVAB scores), the predictive potential increased to 68% for the operators but only to 11.01% for AIT students. The measures did, however, predict learning rate while in training.

Utilization of Findings:

The results of this exploratory effort to explicate and measure Morse code operator performance have direct impact on the Army Intelligence School approach to reduce AIT attrition. Rather than spend resources refining selection measures or suggesting new training strategies, decision makers have asked the U.S. Army Research Institute for the Behavioral and Social Sciences to examine attrition factors in detail and propose solutions to those factors that seem to inhibit the learning process.

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Introduction

The US Army Intelligence Center and School-Devens (USAISD) has ongoing a number of efforts to enhance the training and performance of Morse Operator personnel (Military Occupational Specialty 05H). With the recent designation of USAISD as the executive agent for morse training, this involves the addition of Air Force, Navy, and Marine Corps personnel to the training base. The morse position is also among the most expensive of MOS from recruiting through basic training, to the resident training which involves extensive one-on-one individual computer assisted instruction.

USAISD is reviewing various aspects of the Morse Advanced Individual Training (AIT) in order to keep AIT attrition to a minimum. One such effort is the conversion of their training delivery system from the learning of individual Morse characters followed by incrementing speed of transcription (an analytical approach),to training each character at a high speed and incrementing the number of characters (a perceptual approach). This technology is expected to be implemented in FY 1990.

A more immediate USAISD initiative was to request ARI assistance in identifying factors which are important to becoming a successful Morse operator. For USAISD to determine how to improve their training program, it is first necessary to identify relevant factors critical to performance. This report describes the ARI effort to identify and relate such successful performance factors to successful training performance.

Background

The study of Morse code learning and performance has involved many investigators. As early as 1897, Bryan and Harter performed studies in the physiology and psychology of "telegraphic language", with the finding that certain characters were more difficult to learn than others. In 1919, Thurstone used the learning of telegraphic characters as one domain in which to develop predictive test batteries based on personality characteristics.

With the introduction of the Army Classification Battery just following World War II (1949), interest peaked again toward maintenance and improvement of the tests, which included the Army Radio Code Aptitude Test (ARC-1). Fleishman (1955) evaluated a number of auditory perception tests as predictors of proficiency in code reception, using groups per minute as the criterion measure. In addition to the ARC-1,these included an adaptation of

the Rhythm subtest from the Seashore Measures of Musical Aptitude Test (1938), a Code distraction test requiring detection of number of dots in signal groups presented in rapid succession with background noise, and a dot perception test, which was similar to the Code distraction without the background noise. The ARC-1 predicted proficiency at r=.44, rhythm at r=.34, code distraction at r=.38, and dot perception at r=.31. The advantage of the aptitude tests (rhythm, code distraction, dot perception) over ARC-1 was their ease of administration in the pre-trial learning phase.

Highland and Fleishman (1958) further studied error patterns in receiving Morse code. Errors were organized into meaningful categories derived empirically from error data, then subjected to factor analysis. It was determined that end element substitution errors (responses to auditory numbers or letters that were at the end of a cluster) accounted for the largest number of errors. Fleishman, Roberts, and Freidman (1958) examined 14 psychological and auditory predictors and factored them using the criterion of days taken to achieve code speed of 14 groups per minute. Three of six factors extracted-- speed of closure, auditory rhythm perception, and auditory perceptual speed-- were found to contribute to proficiency. The aural tests gave a better prediction than the written test. Using these early findings, Fleishman and Fruchter (1960) furthered the work to determine predictability of successive stages of learning. The tests used in prior studies, as well as the ARC-1, seemed to do well for early stages of learning, but not for intermediate and later stages. This suggested that motivation and habits of students began to play a role as the learning process developed.

Helme and Dubuisson (1962) also evaluated the ARC-1, discussing its use in the overall Army selection battery, as well as the use of loudspeaker administration versus headphones. Their findings indicated that future work predicting Morse learning would do well to concentrate on distinguishing factors which characterize "good" and "poor" students in terms of habits, behaviors, problem solving measures, motivation and attitudes, instead of purely audio-perceptual skills. Kipnis and Glickman (1959) were early investigators who tested a non-perceptual criterion, supervisory rating, of code proficiency. Their findings were that a good rating depended more on general behavior, such as job willingness, respect for authority, sociability, and supervisor acceptance, than on perceptual ability. Goffard (1960), however, tried to increase student motivation and effort by inserting "meaningful contextual material" midway through the Morse course, and found no significant difference in course completion. Severinsky (1980) reviewed the Morse aptitude measurement problem from its long, historical perspective (dating to the Bryan and Harter studies) and concluded that the ability to predict Morse training aptitude is not much better than chance, and suggested the need to develop a new Morse aptitude "test" drawing on behavioral factors as well as the perceptual components of the task.

The introduction of the ASVAB (Armed Services Vocational Aptitude Battery) motivated a number of new research efforts to predict success in Morse AIT and first term reenlistment. Pearson and Kasporenko (1978), looked at ASVAB combinations of subscores compared to high school/no high school completion, to predict Army MOS retention and found that the ASVAB subscore combinations they devised were better than high school completion or non-completion.

Swanson (1979), in a study of Navy entry code operators, reviewed various ASVAB combinations for their predictive validity, and found very low correlations for a criterion of AIT pass or fail. The trainees in the Swanson study were already preselected, that is, already above the school's ASVAB selection minimum. Mew (1980), in another study of Navy signalmen, used the ASVAB subtests Word Knowledge and Arithmetic Reasoning which were combined into a General Technical composite (GT) score, in addition to the use of a Visual Pattern Discrimination (VPT) test to predict reception of visual Morse code. The GT score was found to be a good predictor for reception of Morse code for high aptitude applicants, but the VPT a better predictor for low aptitude applicants. Rankin (1983) also conducted a study of Navy cryptologic technicians to which Morse code is taught. Rankin's study examined the predictability of academic attrition using all subscales of the ASVAB. A multiple R of .28 was found between all predictors and the criterion of pass/fail but only during the early stages of the training.

Fine (1978) attempted the use of psychologically based indicators to predict attrition from Army AIT at USAISD. This study included subtests from the Wechsler, anxiety measures, and introversion-extroversion measures. Although Fine had over 500 participants, the study became invalid midway through data collection due to changes in recycle policy by the training department.

Wyant and Creel (1982) used ASVAB subscales GT, ST (Science Technical) and Auditory Perception (AP) scores in addition to a number of other psychological test and a demographic survey to predict success of 100 Morse trainees at USAISD. The psychological tests were: an audio version of the Digit Symbol Subscale from the Wechsler Adult Intelligence Scale, the Taylor Manifest Anxiety Scale and the Rotter Internal-External Locus of Control Scale. A discriminant analysis revealed that the audio digit symbol test, audio perception test, and anxiety, as well as achievement motivation scores formed a factor that was predictive of failure 66% of the time. It is noteworthy that the strongest loadings for reasons of student failure appeared to be a combination of adaptational and motivational factors, particularly a sense of depression and lack of personal control in their life. The study did not proceed with a follow on cross validation of the tests used.

Schwartz (1986) explored the development of drop and pass

profiles of Morse AIT students at USAISD using ASVAB "profiles". Using a ranking of scores obtained by each of 114 students, Schwartz developed five categories of scorers, and then examined drop and graduation rates in each category. Since the assignment of individuals to each category reduced the number available for statistical comparison within the categories, the conclusion was that the approach appeared viable to predict attrition if a larger sample could be obtained for validation.

In large part, however, studies at USAISD have been focused on the training environment and the training method (Kreiger, 1981). As mentioned above, a new computer based training system is currently being installed to provide a perceptual learning approach to the training. Therefore, USAISD requested a systematic relook at factors related to Morse AIT and task performance, and this is the subject of the current study.

Objective

The objective of the ARI effort was to identify performance related factors which contributed to the success of Morse operators in the field, and to determine if these factors relate to AIT attrition. This, the effort consisted of three phases:

Phase I Investigation of operators on the job (successful candidates from AIT)

Phase II Relation of identified factors, common to Morse operators, to AIT completion and learning rates

Phase III Formal psychometric cross validation studies to determine if the new variables should be included in the selection test battery

The findings of Phases I and II are presented in this report.

Approach

The approach to Phases I and II of the effort consisted of a series of steps:

Identification of characteristics of successful Morse operators. A task analysis of Morse operations and a personality profile of the Morse operator were developed using data from on-site visits to USAISD and literature review. This set of tasks and personality characteristics consisted of a list of all possible descriptions of successful Morse operators and their qualifications, using such terms as "sociable", "outgoing", "sense of rhythm", "good at concentrating", and many others. This initial list is presented in Table 1.

From this list, unstructured elicitation sessions (focus

Table 1

Initial Morse Code Operator tasks and characteristics elicted from subject matter experts

Accepts challenges, is competitive and outgoing
Moves with purpose, pays attention
Vocal
Extroverted, seeks assistance when needed
Needs little supervision
Uninhibited
Will try anything once
Sense of rhythm
Musical ability
Sense of timing
Manual dexterity
Able to concentrate easily
Typing background
Not college educated or over 30
Not easily distracted
Good memory from one day to next
Suburban or rural background
Good coordination between ear, eye, keyboard
"Space cadet"- nothing phases me
Practical jokester

interviews) were conducted with subject matter experts (SMEs) from USAISD, INSCOM (US Army Intelligence and Security Command, the primary field MACOM for 05H), and MDW (Military District of Washington) individuals currently in DA staff positions but with recent field experience as an 05H operator. A total of 24 SMEs were interviewed (USAISD - 15; INSCOM - 5; MDW - 4). These focus interview elicitation sessions consisted of verbal presentations of the characteristics already identified, giving the SMEs the opportunity to discuss positive and negative reactions to each.

The technique allowed a gradual branching from the exhaustive list to a more concise list, using several iterations over time, toward a core set of characteristics that all in each session agreed were the representative set. In a second series of sessions, the SMEs were verbally presented structured "probe" statements such as "my best operator is" or "I would rely most on someone who", etc., which allowed a sorting of the characteristics into categories that appeared natural for the consensus of SMEs. This iterative focus interview and probe technique has been used successfully in many domains (e.g., Royston, Bercini, Sirken, and Mingay, 1986). The final list is presented in Table 2.

Identification of candidate instruments from standardized test literature to measure the identified operator characteristics. The characteristics of Table 2 were matched to the existing literature of personality and aptitude measures. Since this was a pilot, exploratory study, an effort was made to select tests that not only matched the identified characteristic, but had associated normative data, and required the most simple and efficient administration possible. In order to introduce these candidate measures in the field setting, it was recognized that the total testing time should be kept to a minimum. Table 3 lists the 6 instruments finally selected to represent the identified characteristics of Morse operators. It can be seen that these fall into three categories: Musical aptitude (6 subtests), perceptual-memory measures (3 subtests from larger batteries) and personality indicators (3 subscales from 2 inventories). The rationale for and a description of each specific instrument selected is presented in Appendix A.

Determination of the relationship between test instruments and Morse operator performance and training performance. Using the group of instruments selected above, data was collected to determine the relationship to performance. The instruments were administered to 104 Morse intercept operators at 3 field sites. Their scores on the 6 test instruments were used to determine predictive capability to the performance measure SQT (Skill Qualification Test). Using the same instruments, a second set of data was collected from 100 incoming AIT students at USAISD, and matched to their ensuing academic performance. Both pass or fail as well as learning rate criteria were used for the student group.

Table 2

Core set of Morse Operator Characteristics as synthesized from original list of Table 1

Musical Ability - sense of rhythm and timing
Good memory skills
Perceptual motor coordination - ear, eye, keyboard
Outgoing, sociable nature - extraverted
Able to concentrate, develop mind set
Suburban-rural background

Table 3

Standardized test instruments selected to match identified Morse Operator characteristics

Characteristic	Test Instrument
Musical ability-sense of rhythm and timing	SEASHORE Measures of Musical Talent (6 subtests:pitch, time,rhythm,loudness,timbre, tonal memory)(Seashore,1938).
Good memory skills	Digit memory span (WAIS-R) (Wechsler, 1958).
Perceptual-motor coordination	Digit symbol substitution (WAIS-R) (Wechsler, 1958).
	Perceptual speed (ETS kit of factor referenced tests) (French, Ekstrom, & Price, 1976).
Outgoing, sociable nature	EYSENCK personality inventory for dimensions introversion/ extraversion and stability (Eysenck, 1947).
Ability to concentrate, develop mind set	TELLEGEN Scale for sustained attention capacity (Tellegen & Atkinson, 1974).
Suburban-rural background	Demographic fact sheet (Appendix D).

Determination of the relationship between existing predictors (ASVAB) and the new test instruments. For both the operator and student groups, ASVAB scores were obtained (as available) and added to the prediction equation for on-the-job or academic performance. These data provided the means to judge the utility of pursuing further psychometric validation of the new instruments as a selection technique.

Phase I: 05H Operator Performance

Method

The 6 instruments listed in Table 3 above were administered to Morse operators at three INSCOM field sites. The tests were scored and entered into a data file along with SQT data obtained from the Enlisted Master File (EMF). Concurrently, each shift supervisor was asked to rate operators using a Behaviorally Anchored Rating Scale (BARS) adapted from the Army-Wide Performance Rating Scale. This scale contained items related to Morse intercept tasks, general job procedures, and attitude and ethics. The entire data set was analyzed using multiple regression analysis to show predictive capability of the 6 instruments to performance.

Participants. Operator participants (N=104) were drawn from 3 Field Stations representative of 05H missions within the MOS: F.S. Augsburg (Augsburg, FRG), F.S. San Antonio, (Kelly AFB, TX), and CONUS MI Group, (Ft. Meade, MD). Each individual had been on the job at least 6 months (and so was considered proficient) but had not been out of school longer than 3 years (had received USAISD training under the same method and recycle policy). Most operators were grade E-4 with a small percentage E-3 or E-5. The demographic characteristics of the total group are presented in Table 4.

Test Materials. As listed in Table 3, the 6 tests were drawn from available standardized tests. All required simple paper and pencil responses. In addition, a demographic fact sheet was included in the test packet to gather certain background data as had been identified as pertinent by the SMEs. Appendix B contains a copy of the demographic fact sheet filled in by each operator. Finally, the supervisory rating scale filled in for each operator was given to supervisors for each shift tested. Appendix C contains the supervisory rating scale.

Procedure. The testing sessions were conducted on site at the INSCOM Field Stations during all shifts, until all the available 05H operators meeting the 6 months to 3 year on-the-job prerequisite had been tested. Each session lasted about 90 minutes, and consisted of timed as well as self-paced items, according to instructions for each instrument. The Seashore Measures of Musical Aptitude was presented via tape recording of the original 33 rpm record from the administration kit. Each

Table 4

Demographic Characteristics - Operator participants (N=104)

Field Station Augsburg	54
Field Station San Antonio	27
Conus Mi Group, Ft. Meade	23
Male	85
Female	19
Age	
20-25	76
> 25	28
Experience	
1-3 yrs in service	66
> 3 yrs in service	38
Education	
High school	80
Some college	24
Geographical background	
Urban	15
Suburban	49
Rural	40
Prior Morse training	
Yes	4
No	100
Prior typing skill	
Yes	55
No	49
Plays musical instrument	
Yes	32
No	72

participant was handed a packet of answer sheets, and given privacy act information to allow voluntary participation. Since each site necessitated small group sessions due to 24 hour shifts, the order of tests in each was randomized across sessions and Field Stations to minimize fatigue effects. Concurrently, supervisors were asked to fill out the supplied rating form for each operator under their supervision. All test and rating materials were completed during a several day visit at each site.

Data Analysis. Tests from all sessions were scored using keys and recorded in a data file along with obtained SQT scores (if available) and the supervisor's ratings. The operator scores were then compared to statistical norms. Correlations were computed between the obtained SQT scores and demographic factors to detect any significant intragroup differences. A correlation matrix among ratings, SQT, and current ASVAB predictor scores (AA) was computed.

These were followed by stepwise regression equations to show the predictive capability of the 12 measures (6 subscales on one test and 5 other tests) to the criteria SQT and supervisor rating. An additional predictive equation was developed to show the added contribution (if any) of demographic factors. The regression analysis procedure selected was PROC STEPWISE from the SAS program of statistical analysis procedures (Chapter 37). PROC STEPWISE was selected due to the widespread use in providing models most helpful for exploratory analysis, since it provides five methods for stepwise regression (Forward, backward, stepwise, MAXR, MINR), and its efficiency in use of computer time. A survey article by Hocking (1976) describes these variable selection methods. The stepwise technique begins with no independent variables in the model, and then calculates F statistics reflecting the variable's contribution to the model if it is included. These F statistics are then compared to a selected entry value for significance. For this exploratory effort, an F value of $p < .15$ was used.

Results

Comparison to general population norms. The relation of the Morse operator group to general population norms is presented in Figure 1, for the musical aptitude subtests and the perceptual-memory tests. The operator group is clearly above the general population in the musical aptitude subtests rhythm and time, as well as digit symbol substitution. Performance on perceptual speed is just above average, and digit span is average. For personality measures, Figure 2 shows the comparison of the operators to other adult groups on the introversion-extraversion and stability-changeability scales. Here it can be seen that the operator group is close to the adult norm for stability with an inclination toward extraversion. Finally Figure 3 presents the Tellegen self absorption scale findings. The operator group does not fall into a category of high capacity for sustained attention.

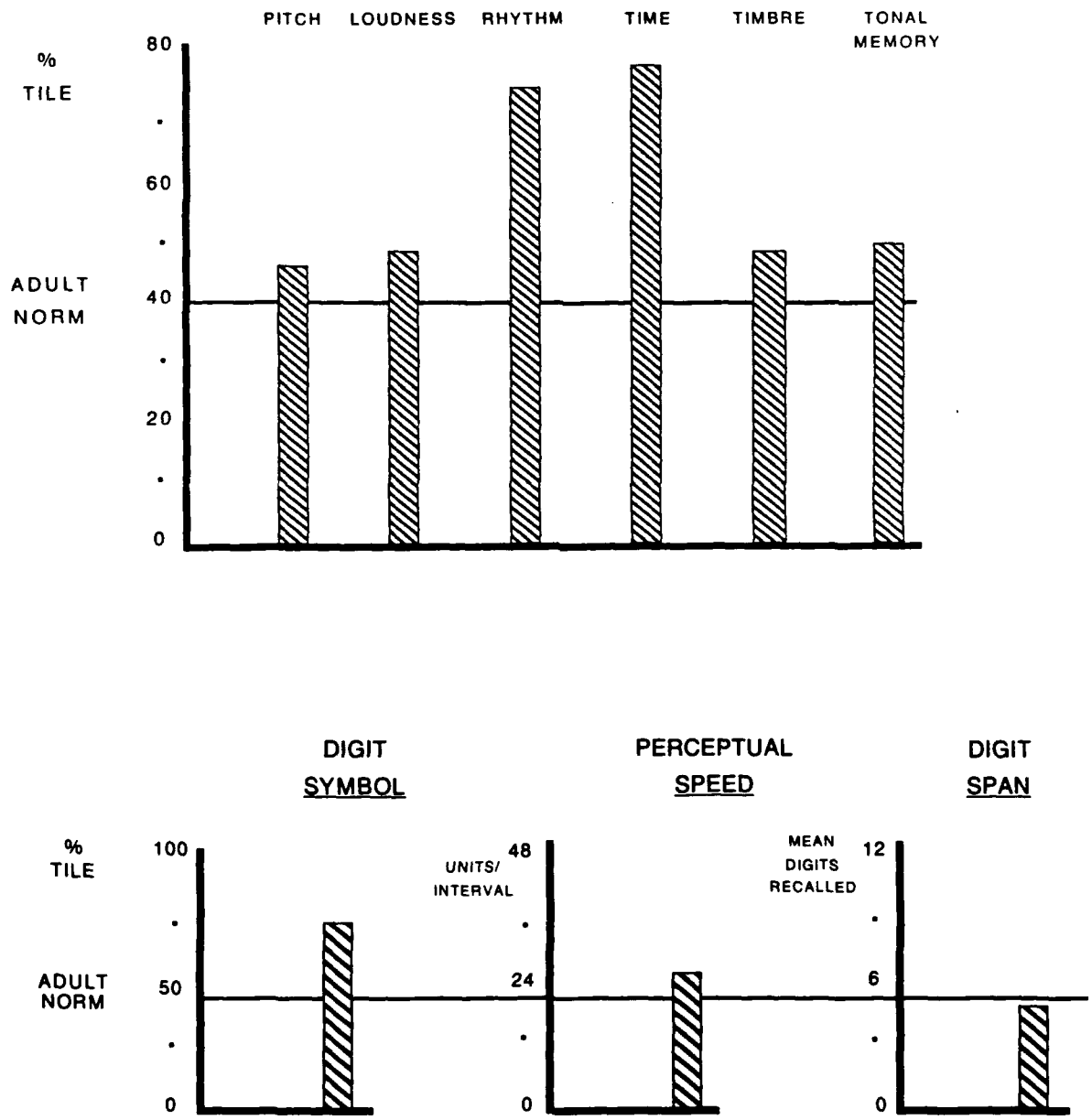

Figure 1. Comparison of Morse Operator scores on Seashore Measures of Musical Aptitude Test, Digit Symbol Substitution, Perceptual Speed Test, and Digit Memory Span to population norms.

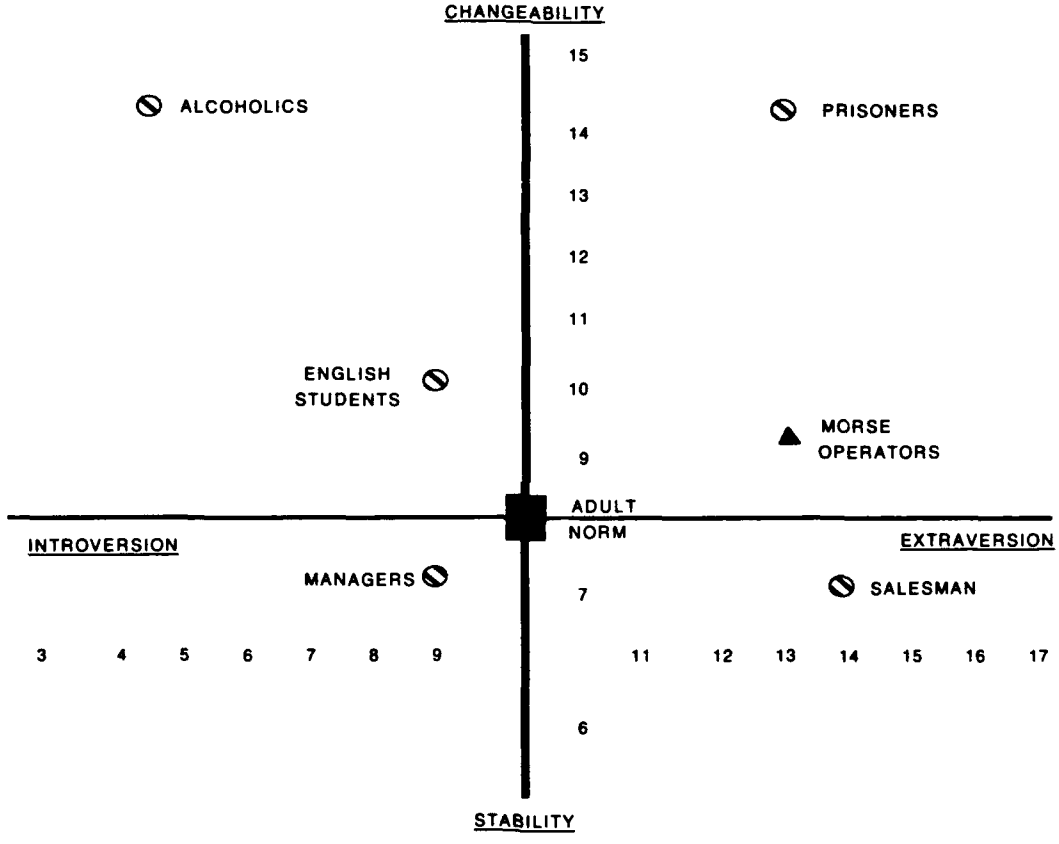

Figure 2. Comparison of Morse Operators to general adult norms and selected adult populations on personality dimensions of introversion-extraversion and stability-changability.

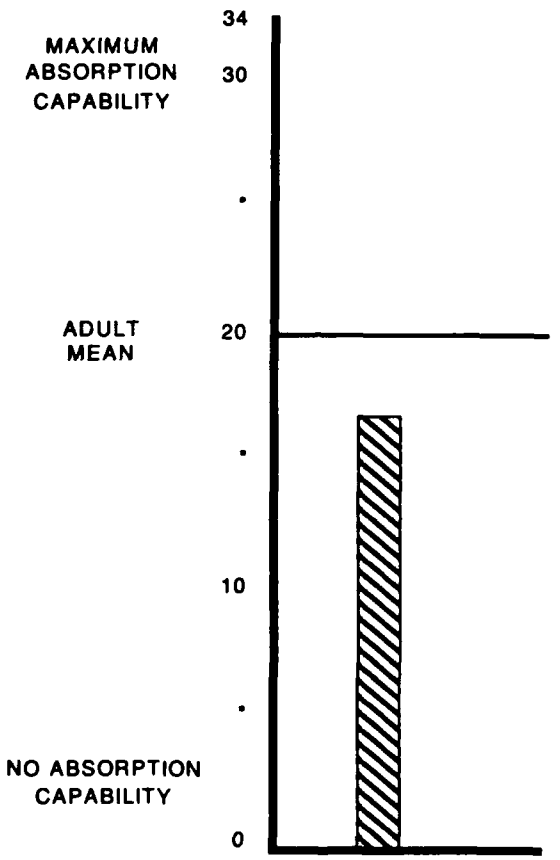

Figure 3. Comparison of Morse Operator scores on Tellegen Capacity for Sustained Attention Scale to adult norms.

From a descriptive point of view, the comparison to norms indicates that the rhythm and time measures, which are intuitively related to the Morse task, are prominent in this group. Similarly, digit symbol substitution and perceptual speed involve abstract tasks which appear to be perceptual components of the real world task. There is no way to ascertain whether the group acquired these through experience or through selection, however. In the personality area, the group exhibits no alarming instability and shows a tendency to extraversion. These were hypothesized initially by the subject matter experts, who often described the operator population as outgoing, "practical jokers" who "appeared crazy" in order to cope with the inherent boredom and stress of the job. The "craziness" appears to be a facade as opposed to actual instability. For the sustained attention capacity, the operator group appeared opposite to original projection, that is, as opposed to having a high level of this capacity, they had very little. This capacity is associated with individuals who can easily daydream, are good subjects for hypnotic suggestion, and can block out external stimulation. It appears that the operator group conform more to a need for external stimulation and are more reality driven.

Relation of demographic characteristics to SQT scores. Seven demographic characteristics were related to test score performance: male/female (although distribution limited), age, experience level, education (college/no college), prior typing ability, prior musical ability, and geographical background (urban, suburban, rural). Prior Morse ability was dropped as a useful factor for discrimination since 100 of the 104 operators had no prior Morse experience. Table 5 shows zero order correlations between the seven characteristics and SQT. From the correlations obtained, only the gender variable (male/female) produced a significant correlation ratio ($r = -.2367$, $p = .039$). This may indicate that males tend to do slightly better on SQT for this MOS; however since the N size proportionality on this factor, it must be interpreted with caution. No other demographic factors show a significant trend.

Relation between SQT, supervisor ratings, and AA scores. Correlations were computed between the subscales within the supervisory rating scale and between the overall rating and SQT, as well as AA (Area Aptitude Score -ST) to SQT. Two purposes were served by this analysis: to determine if the total BARS score could be used as a criterion measure, and to determine if supervisory ratings were related to the more quantitative SQT measure. This helps to determine if the SME inputs were valid (did the BARS work).

First, the supervisory rating scale, which consisted of three sections, showed almost as high a relationship between each section as to the overall supervisory rating. As shown in Table 6, the interrelationship between technical performance and attitude and ethics is a high of $r = .61$. Other correlations are even higher, ranging from .72 to .94. From this it can be

Table 5

Zero order correlations for demographic factors x SQT scores: Operator group

	SQT
Gender	-.2368 *
Prior musical instrument	.0813
Education (High school/ some college)	.0804
Prior typing	.1313
Age (Under/over 25)	.1089
Area (Urban,suburban, rural)	.1409
Experience (1-3 yrs in service/ vice > 3 yrs)	-.0869

* Significant at .05 level of confidence

Table 6

Zero order correlation coefficients for supervisory rating scale scores x overall supervisory rating

	Technical Performance	Procedural Performance	Attitude & Ethics
Procedural Performance	.7195		
Attitude & Ethics	.6084	.8187	
Total Performance	.8287	.9368	.9278

Zero order correlation coefficients for SQT x total supervisory rating and AA(ST) score

	Total Rating	AA(ST)
SQT	.4842	.4612

All correlation coefficient values are significant at .0001 level of confidence.

concluded that a high rating on one section nearly always indicated a high rating on any other section, and that the overall rating is a stable indicator of supervisor assessment of an individual's performance.

Second, the correlation coefficients shown in the lower half of the table show the relation between SQT (the established criterion of MOS task performance) and the existing ASVAB predictor (AA composite), along with the obtained overall supervisory measure. The obtained correlation of r=.48 for the rating scale is comparable to the r=.46 for the AA score. This indicates that the supervisory rating scale is as good at predicting task performance as the established predictive measure.

Stepwise regression results. Table 7 depicts the obtained zero-order correlation, the multiple R, R2, and the step increase in R values for the operator sample using the SQT criterion. Only three test measures met the preset cutoff value for significance for the F value of $p < .15$: digit span, Tellegen measure of sustained attention, and pitch musical aptitude score. These three measures accounted for 29% of the variance in the model. Table 8 shows the zero-order correlation, multiple R, R2, and the step increase in R values for a regression model using supervisory rating as the criterion. Although some of the same test predictors achieved the cutoff value of $p < .15$ for F, digit span and pitch, the tests do not have the same predictive power (14%) to determine supervisor judgment. It is noteworthy that two of three variables found in the SQT equation are pertinent for the supervisory rating.

It is important to reiterate that this was an exploratory effort and thus the obtained R2 may be inflated due to overfitting or "shrinkage". Whenever the number of predictors approaches the N size, some inflation of the relationship may be in effect. Some investigators have suggested a desirable ratio of 30 subjects per predictor variable in order to minimize shrinkage (Pedhazur, 1982). In this effort, the ratio is approximately one-third this requirement. Some formulas for the estimation of shrinkage have been proposed (e.g., Pedhazur). This suggests that the obtained R2 must be interpreted as important data, but not a final value, and that it provides an initial picture of predictor potential. Although a cross validation study is indicated to best estimate the degree of shrinkage and give more reliable estimates of the true R2, this was not feasible due to student availability, a need for relatively rapid information, and agreement among investigators and sponsors that the nature of the effort was an exploratory, initial fact-finding endeavor.

The demographic variables were forced in first for inclusion in a final regression equation, the results of which appear in Table 9. This indicates the impact of the demographic factors when considered in relation to those new tests that were predictive (Digit Span, Pitch, Tellegen). The only demographic factor that

Table 7

Summary of Stepwise Regression Analysis for Morse Operator SQT performance using 12 new test instruments

Criterion	Tests	Zero Order r	Multiple R	R2	Increase in R
SQT	Digit Span	.3821*	.3821*	.1460	.3821
	Tellegen	-.3616*	.4779*	.2284	.0958
	Pitch	.3038*	.5402*	.2918	.0623
	(No other test instruments met default significance level of p < .15)				

* Significant at .001 level of confidence

Table 8

Summary of Stepwise Regression Analysis for Morse Operator BARS performance using 12 new test instruments to predict rating

Criterion	Tests	Zero Order r	Multiple R	R2	Increase in R
Supervisory Rating	Digit Span	.2575*	.2575*	.0663	.2575
	Pitch	.2339*	.3187*	.1015	.0612
	Percep Speed	.1603	.3656*	.1337	.0469

(No other test instruments met default significance level of p < .15)

* Significant at .05 level of confidence

Table 9

Summary of Stepwise Regression Analysis for Morse Operators Performance adding demographic variables as predictors

Criterion	Variable	Zero Order r	Mulitple R	R2	Increase in R
SQT	Digit Span	.3821**	.3821**	.1452	.3821
	Tellegen	-.3616**	.4604**	.2234	.0783
	Pitch	.3038**	.5297**	.2928	.0693
	Typing	.1313	.5715*	.3346	.0418
	(No other demographic variables met the default significance level of p < .15)				

** Significant at .01 level of confidence
* Significant at .05 level of confidence

adds to predictive capability for operator performance is typing skill (R2= .0418). The suggested impact of geographical area, although showing a positive zero order correlation (Table 5) was not predictive.

Discussion

The data on the Morse operators indicates that the group has characteristics that are different than adult statistical norms in certain subcategories of musical aptitude, perceptual skill, and has a tendency toward extroversion in personality. Some measures (on test scores) in these categories are predictive of actual field performance (SQT): digit span, Tellegen sustained attention scale, and pitch. These results show the viability of new performance factors to measure and predict Morse operator task performance. There is very little indication that geographical background is related to task performance, as had been suggested. Typing ability does however play a small role, in that those with typing proficiency tend to do slightly better on the SQT. This finding and its implication would require further study to reveal its utility for performance prediction. The new performance factors could also have an impact on performance in the training environment since there will be some difference between the demands of training and the demands of operational performance. The data collection of Phase II which follows was designed to explore this issue.

Phase II: Relation of Morse Characteristics to Training (AIT) Performance

Method

The 6 instruments of Table 3 were administered to 100 incoming 05H Army AIT students and 63 incoming Air Force AIT students at USAISD. The tests were scored as for the operators above and entered into a master data file along with criterion measures, ASVAB scores, instructor ratings, and demographic characteristics.

The criterion performance measures were selected after consultation with USAISD instructors. These measures consisted of number academic pass or fail candidates, as well as 3 learning rate values: hours to complete Bravo 26 phase (learning of the 26 alphabet characters) and hours to complete Delta 20 phase (learning of copy speed 20 groups per minute), and early completion candidates from the population who passed.

Concurrently, each instructor rated students using a BARS rating scale similar to the operator instrument (Appendix E). The instructor rating scale had sections related to learning performance, attitude, and motivation. The entire data set was analyzed using multiple regression analysis to show predictive

capability of the 6 instruments to AIT performance.

Participants. Student participants were drawn from all entrants to AIT at USAISD in the Morse training from October to January, which gave an N=100 Army individuals and N=63 Air Force. It was of secondary interest to USAISD to monitor the Air Force group in addition to the Army. Although the original group consisted of N=163, the final group available for statistical analysis was N=108 (Army=59, Air Force=49). As the course progressed, 55 participants were deleted from the initial group for the following reasons:

All administrative drops	24
No course status	6
Missing test scores	16
Exceptions to policy	8
Outlier	1
	--
	55

The chart in Table 10 shows the breakout of the initial and final (adjusted) samples, based on pass/fail categories of interest to USAISD.

As can be seen, the overall attrition rate in this group was around 50% for each service component. Table 11 shows the demographic characteristics collected for each group, in 7 categories: gender, age group, education (high school only or some college), geographical background, prior musical instrument, prior typing skill, and prior Morse training. Only 4 variables, gender, geographical area, musical instrument, and typing skill, provided distributions adequate for inclusion in further analysis.

Test Materials. The 6 tests of Table 3 were used as in the operator group above. Appendix D contains the student demographic fact sheet, and Appendix E the instructor rating sheet.

Procedure. The testing sessions were conducted at USAISD as part of the student in-processing procedure. A two hour block was dedicated to the test administration. The presentation of each is as described in the operator phase above. Instructors rated each student under their supervision during the third week of class. This time frame was selected after prior consultation with the instructor cadre provided consensus that they could "size up" a student's potential for success within two weeks. Students reported for AIT at the rate of approximately 5-20 per week. Since the course is self-paced up to a maximum of 2 recycles or 21 weeks, the entire data set was complete in six months time.

Data Analysis. A careful review of the Army and Air Force data files for both the demographic characteristics (shown in Table 11) and the criterion measures (shown in Table 12) revealed a close similarity in the distributions for each. The major difference between the two groups was in hours to pass Delta 20.

Table 10

Initial and Final (Adjusted) AIT Student Participants

INITIAL GROUP

	PASS			FAIL			
	Early	Regular	Exception to policy	Academic	Administrative Med	Secur	Oth
ARMY N=100	6 6%	27 27%	5 5%	35 35%	20 20%	1 1%	0 0
AIR FORCE N=63	14 22%	16 25%	3 5%	26 41%	2 3%	0 0	1 .1%

FINAL (ADJUSTED) GROUP

	PASS		FAIL
	Early	Regular	Academic
ARMY N=59	5 8%	23 39%	31 53%
AIR FORCE N=49	13 27%	12 24%	24 49%

Table 11

Army/Air Force AIT Student Comparisons on Demographic Factors

Factor	ARMY (%)	AIR FORCE (%)
Male	79	69
Female	21	31
Age Group		
< 25	91	100
> 25	9	0
Education		
High school	83	90
Some college	17	10
Geographic area		
Urban	39	16
Suburban	40	47
Rural	21	37
Prior Musical Instrument		
Yes	40	39
No	60	61
Prior Typing		
Yes	72	73
No	28	27
Prior Morse		
Yes	3	0
No	97	100

Table 12

Army/Air Force AIT Student Comparison - Criterion Measures

MEASURE	ARMY	AIR FORCE	
Overall attrition (%)	53	49	
Bravo 26 (hrs to complete)	80.2	83.2	n.s., p > .05
Delta 20 (hrs to complete)	540.9	412.8	t=2.82, p <.01
Mean instructor rating (total of 60 points)	46.0	49.3	n.s., p > .05

However the overall attrition rate for each group was not significantly different (53% Army, 49% Air Force). With this, and in an effort to maximize statistical power, the two groups were collapsed into one with a total N=108). It was upon this group that comparison to statistical norms, correlation matrix, and stepwise regression equations were conducted, as in the operator phase.

Results

Comparison to norms and operator scores. The Morse student group test performance is shown in Figures 4-6. Figure 4 shows the relation of the student group to adult norm percentiles on the musical aptitude measures and the perceptual and memory tests (perceptual speed, digit symbol substitution, and digit span). In addition, the operator findings on the measures are provided for comparison. The student group is more like the average adult on all 9 measures, although the trend to have higher musical aptitude scores for rhythm and time is evident. Digit span and perceptual speed show no difference from the operator group (both slightly above average),while the digit symbol , which was statistically lower than the operator group, is still above adult norm average.

For the personality dimensions of introversion-extraversion and stability-changeability, shown in Figure 5, the student group is closer to the overall adult norm (not overly extraverted or changeable) compared to the operators. On the Tellegen sustained attention capability scale, shown in Figure 6, the student group is slightly higher (closer to having the disposition for absorption- less reality driven) than the operators, however still not in the category of high sustained attention for adults as documented by the Tellegen studies (e.g. 1974).

In general the student group exhibits similar characteristics as in the operator group, although not with the same homogeneity. The student group appears slightly less skilled, possessing lower aptitudes, and closer to the general adult population in personality. This suggests that the conditions of the job environment may sharpen skills, build aptitudes, and more clearly define personality characteristics. This inference is only speculation suggested by the data trends, and would require substantiation in another study.

Relation of demographic characteristics to criterion measures. A correlation matrix among 5 (gender, education, area, prior typing experience, and prior musical instrument) of the 7 demographic characteristics (shown in Table 11) was computed and is shown in Table 13 (excluding age, and prior Morse since an adequate distribution was not available on these).

The only significant correlations occur for prior typing skill, and prior musical instrument ability. Typing skill seems to enhance early phase learning ($r=.28$, $p < .05$), yet no

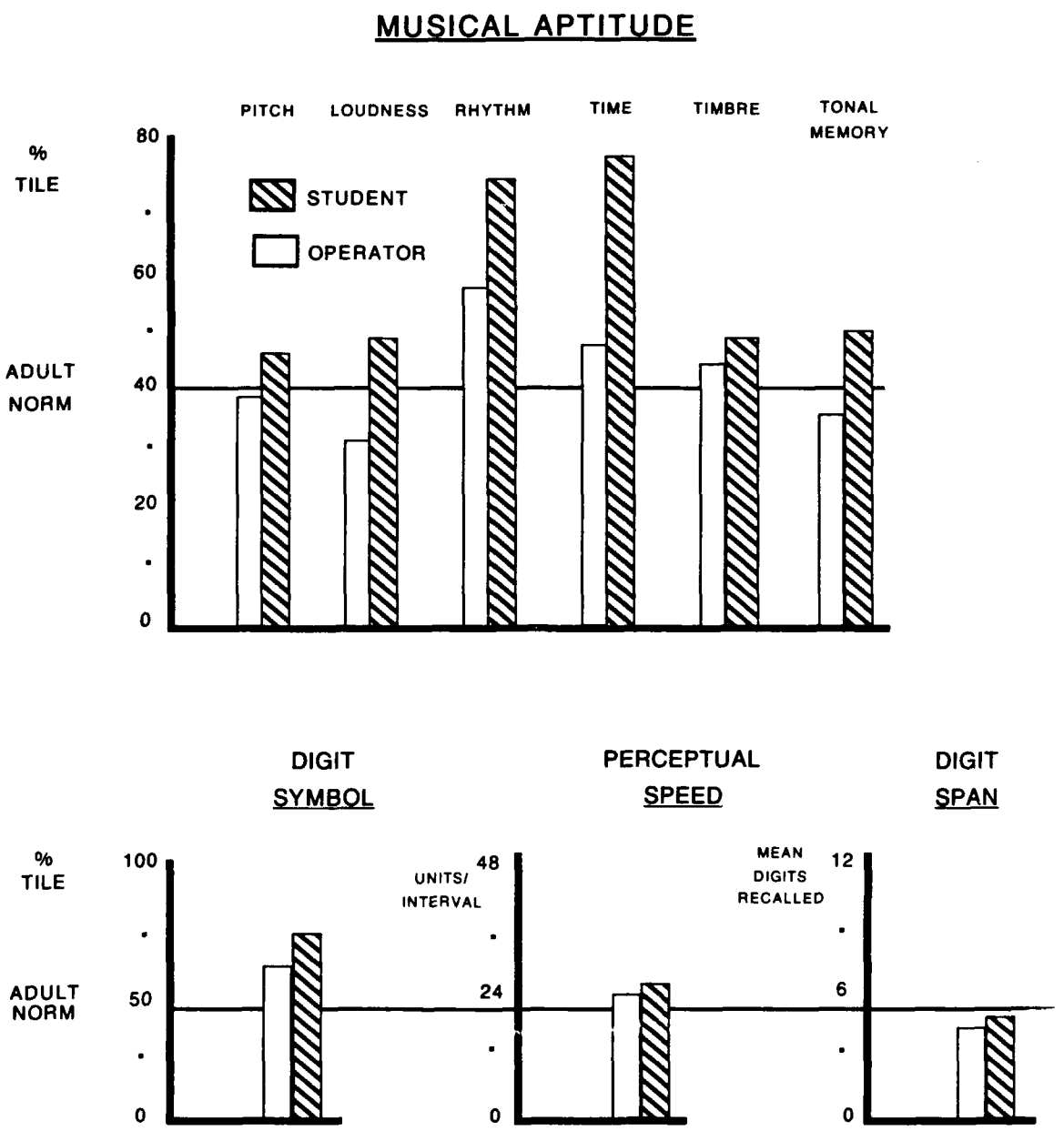

Figure 4. Comparison of Morse AIT student scores and Operator scores on Seashore Measures of Musical Aptitude Test, Digit Symbol Substitution, Perceptual Speed Test, and Digit Memory Span, to population norms.

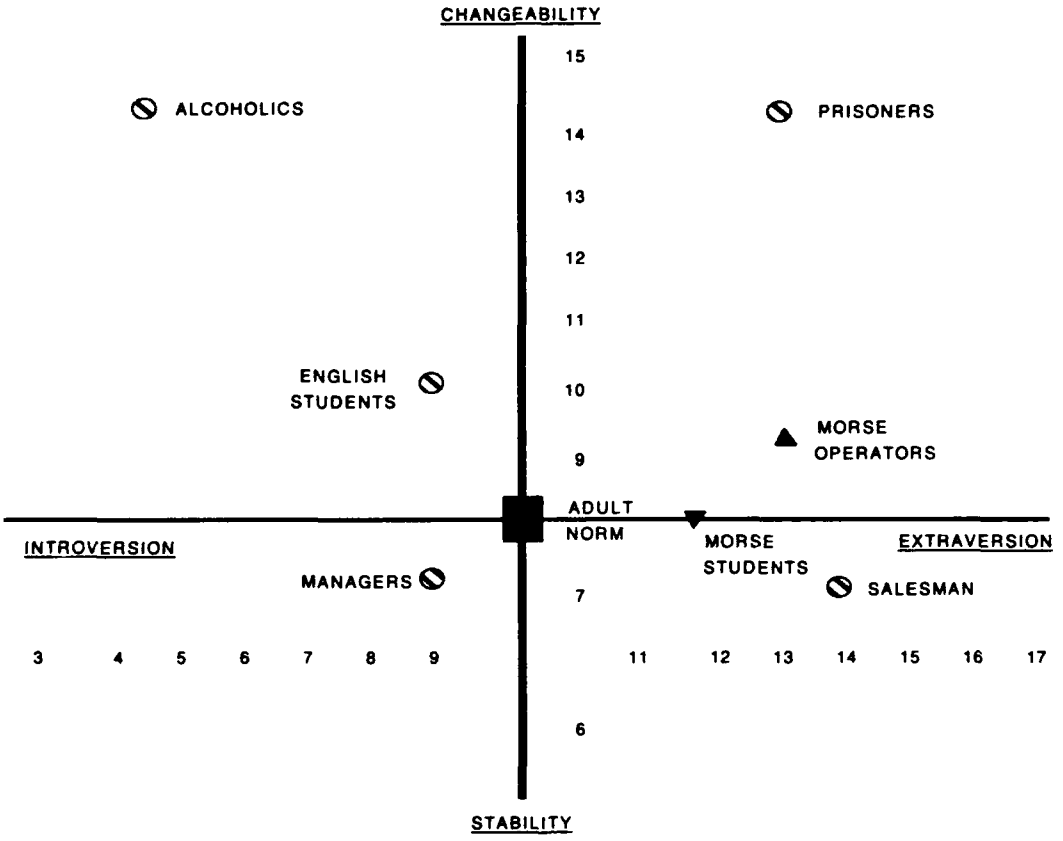

Figure 5. Comparison of Morse AIT students and Operators to general adult norms and selected adult populations on personality dimensions of introversion-extraversion and stability-changability.

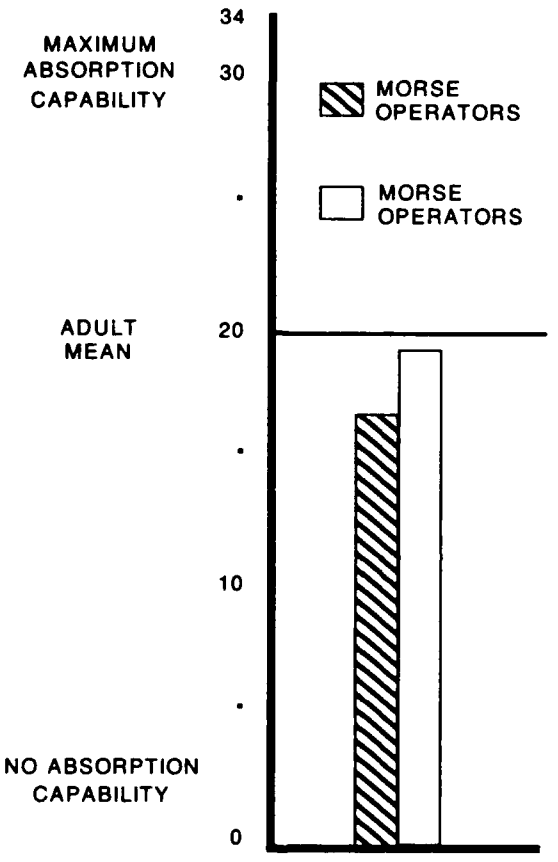

Figure 6. Comparison of Morse AIT student and Operator scores on Tellegen Capacity for Sustained Attention Scale to adult norms.

Table 13

Zero-order correlations for demographic factors x AIT criterion measures - Student group

	Pass/Fail (n=108)	Early/Regular Grad (n=53)	Bravo 26 (n=93)	Delta 20 (n=53)
Gender	.0269	-.2029	-.1356	-.2005
Education (High school/ some college)	-.1277	.0882	-.0608	.0751
Area (Urban, suburban, rural)	-.0752	-.0020	-.1132	-.1080
Prior musical instrument	-.0152	.3897**	.0429	.3178*
Prior typing	.1108	-.0193	.2800**	-.0571

** Significant at .01 level of confidence
* Significant at .05 level of confidence

significant contribution to later learning or course attrition. The finding on typing skill may be an artifact of the student progression system at the school, that is, those individuals with prior typing skill are processed into early learn phase very quickly, whereas those with no prior typing are given more typing drill. This allows those with some initial skill to log in more hours in the learn phase of code, and thus may attain greater proficiency faster. This would then even out in both (prior and non-prior skilled typing) groups in the speed building (Delta) phase.

Those who played a musical instrument show a capability as well to pass through the learning process more quickly, in picking up the speed increment taught in Delta phase ($r=.3178$, $p<.05$), and to graduate early ($r=.3897$, $p<.01$), but these musical skills are not a predictor of attrition in AIT.

Correlation of instructor ratings and criterion measures. Table 14 shows correlations between ratings subsections, overall ratings, and obtained performance measures. As in the operator ratings, the intercorrelations among the scale subsections (training performance, effort, and motivation) are very high ($r=.7906, .6473, .7270$; all significant at $p<.01$); and the relation of the subsections to overall rating is even higher ($r=.8841, .8851, .9362$). These indicate that the overall rating score is a viable index of instructor judgment of student capability.

Using the overall rating and relating to performance criteria, instructors do best at determining early learning potential (Bravo $r=-.4852$, Delta $r=-.3711$; $p<.01$), meaning that the higher the rating, typically the fewer hours needed to pass early and later learning phases. For whether the student will ultimately graduate, however, the relation is less powerful (Pass/Fail, $r=.3197$; $p<.05$). Even though some relation exists, it is clear that instructors are better able to identify who can learn the Morse skills needed to do the job, rather than who will complete the course.

Finally, the set of correlations at the bottom of Table 14 shows the interrelationship of early learning (Bravo 26) to the other criterion measures. It can be seen that those who do well in the first phase of learning (Bravo) will tend to do well in the second phase (Delta), $r=.5018$, $p<.01$. Also, the rapid learners in Bravo tend to be early graduates ($r=.4116$) -- if they graduate. However, the relationships drop sharply in predicting course completion, that is, a promising early learner does not necessarily indicate a course graduate. Other factors are impacting course completion besides the capacity for rapid mastery of the basic code characters.

Stepwise regression results. Tables 15-18 depict the obtained zero-order correlation, the multiple R, R2, and the step increase in R values for the student group on the criterion measures pass/fail, hours to Bravo 26, hours to Delta 20, and early versus

Table 14

Zero-Order Correlation Coefficients for instructor rating subscales x overall instructor rating

	Training Performance	Effort	Motivation
Effort	.6473		
Motivation	.7906	.7270	
Total Rating	.8841	.8851	.9362

All r values are significant at .001 level of confidence

Zero-Order correlation Coefficients for total instructor rating and student criterion measures

	Total instructor rating
Pass/Fail	.3179*
Early Graduate	-.2307
Bravo 26	-.4852**
Delta 20	-.3711**

** Significant at .01 level of confidence
* Significant at .05 level of confidence

Zero-Order Correlation Coefficients for Bravo 26 and later AIT performance

	Bravo 26
Delta 20	.5018**
Early Graduate	.4116**
Pass/Fail	-.2693*

** Significant at .01 level of confidence
* Significant at .05 level of confidence

regular graduate. In each case, only 1-3 predictors met the criterion for significance level set at p (F) < .15.

For the pass/fail criterion, (Table 15) 3 new tests -- rhythm musical aptitude, digit memory span, and Tellegen capacity for sustained attention scale-- have predictive power in determining whether an individual will ultimately pass the Morse AIT. An immediate parallel to the operator data can be seen in that the 3 variables predictive of SQT performance were digit span, Tellegen scale, and pitch musical aptitude. Note that rhythm and pitch are positively correlated in the operator group (r=.1600), making it reasonable to hypothesize that a more fundamental musical ability factor exists. In addition, the regression analysis on the pass/fail criterion indicates that only 11% (R2=.1136) of the variance for AIT attrition is accounted for by these instruments.

With regard to learning rate, for hours to reach Bravo 26 phase, (Table 16), 3 instruments also proved predictive of this criterion-- perceptual speed task, timbre musical aptitude, and digit memory span. Two are perceptual-memory skills and one is a musical aptitude factor, timbre. More variance (R2=.1430) is accounted for by these variables than for pass/fail of 11%. For the Delta 20 (speed building) learning phase, Table 17 indicates that only the introversion-extraversion scale is predictive of performance. The variance accounted for is R2 = .1492. Finally, for the learning rate criterion of early graduation versus regular pace of learning (Table 18), the obtained R2 of .0947 is determined from one instrument which met the cutoff value-- digit symbol substitution.

As in the operator group, demographic factors were entered into regression equations (forced in first) for AIT student performance. Tables 19-21 show the contribution of certain demographic factors as extending the predictive power of the new tests. For pass/fail, no demographic factor met the significance criterion beyond the three tests already identified (Table 15).

In the area of learning rate, for hours to reach Bravo 26, typing skill accounts for 8% of variance (Table 19); as discussed above in the correlation findings on the five demographic variables, this may be an artifact since those with prior typing skill are assigned to code character learning sooner than those with no prior typing. Prior musical instrument training is important in hours to Delta 20 (13 % of variance, shown in Table 20), and early graduation potential (20% of variance, shown in Table 21).

These findings are intuitively logical since the early learn phase (Bravo, learning of 26 alphabet characters) is characterized by the learned transfer of the identified perceptual signal to keyboard output. Once basic characters have been learned and speed building is the objective (Delta phase), the rhythm and pattern detection skills of a musician play a role in aiding an individual through Delta phase and foster early

Table 15

Summary of Stepwise Regression Analysis for Morse AIT Student Attrition performance using 12 new test instruments as predictors

Criterion	Tests	Zero Order r	Multiple R	R2	Increase in R
Pass/Fail	Rhythm	.2229*	.2229*	.0497	.2229
	Digit Span	.2195*	.2549*	.0817	.0320
	Tellegen	-.1772	.2867*	.1136	.0318
	(No other test instruments met default significance level of p < .15)				

* Significant at .05 level of confidence

Table 16

Summary of Stepwise Regression Analysis for Morse AIT Student Bravo performance using 12 new test instruments

Criterion	Tests	Zero Order r	Multiple R	R2	Increase in R
Bravo 26	Percep Speed	-.2701**	.2701**	.0729	.2701
	Timbre	-.1858	.3146*	.1174	.0445
	Digit Span	-.1974*	.3401	.1430	.0255
	(No other test instruments met default significance level of p < .15)				

** Significant at .01 level of confidence
* Significant at .05 level of confidence

Table 17

Summary of Stepwise Regression Analysis for Morse AIT Student Delta 20 performance using 12 new test instruments

Criterion	Tests	Zero Order r	Multiple R	R2	Increase in R
Delta 20	Introversion/ Extraversion	-.3863*	.3863*	.1492	.3863
	(No other test instruments met default significance level of $p < .15$)				

* Significant at .01 level of confidence

Table 18

Summary of Stepwise Regression Analysis for Morse AIT Student Early graduation performance using 12 new test instruments

Criterion	Tests	Zero Order r	Multiple R	R2	Increase in R
Early vs. regular graduate	Digit symbol	-.3078*	.3078*	.0947	.3078
	(No other test instruments met default significance level of p < .15)				

* Significant at .05 level of confidence

Table 19

Summary of Stepwise Regression Analysis for Morse AIT Student Bravo performance adding demographic variables as predictors

Criterion	Variables	Zero Order r	Multiple R	R2	Increase in R
Bravo 26	Typing	.2800**	.2800**	.0854	.2800
	Percep Speed	-.2701**	.3555**	.1609	.0755
	Timbre	-.1858	.3918*	.1971	.0363

(No other variables met the default significance level of $p < .15$)

** Significant at .01 level of confidence
* Significant at .05 level of confidence

Table 20

Summary of Stepwise Regression Analysis for Morse AIT Student Delta 20 performance adding demographic variables as predictors

Criterion	Variable	Zero Order r	Multiple R	R2	Increase in R
Delta 20	Prior musical instrument	.3179*	.3179**	.1355	.3179
	Introversion/ Extraversion	-.3863*	.4159**	.2335	.0980
	(No other variables met the default significance level of p < .15)				

** Significant at .01 level of confidence
* Significant at .05 level of confidence

Table 21

Summary of Stepwise Regression Analysis for Morse AIT Student Early graduation performance adding demographic variables as predictors

Criterion	Variable	Zero Order r	Multiple R	R2	Increase in R
Early vs. regular graduate	Prior musical instrument	.3897**	.3897**	.2008	.3897
	(No other variables met the default significance level of p < .15)				

** Significant at .01 level of confidence

graduation. The role of a musically inclined individual is particularly compelling for the early graduate (R2=.2008).

As a final note, the comments in the previous section on operator findings pertaining to R2 shrinkage apply to the above student results as well (see p. 18).

Discussion

The data on the Morse AIT students indicates that measures shown to be viable for operators are also playing a role in student performance; however, the amount of variance accounted for in the student group is much smaller (maximum of 14% achieved to predict Delta 20, as opposed to 29% accounted for in the operator group SQT measure). Table 22 recaps the R2 values for significant factors in the various regression equations, for both operators and students, with and without the demographic variables, on the criterion performance measures of SQT, attrition (pass/fail) and learning rates.

The fact that the Tellegen scale and digit span measures, along with a musical aptitude measure (pitch for operators, rhythm for students), were found to be predictive of successful performance in both groups (SQT for operators, attrition for students), indicates that some core characteristics of the Morse task are being addressed. Pitch and rhythm, in addition to being positively correlated (r=.1600), are intuitively related to the task as well. Listening to code certainly requires being attuned to rhythmic streams of signals, and distinguishing high from low signals is the analog of the pure pitch aptitude. Other aptitude measures (timbre musical aptitude, perceptual speed, digit symbol) as well as a personality dimension (introversion-extraversion) were related to learning rate but not attrition performance (ultimate success).

For the students, two demographic characteristics (prior musical instrument training, and prior typing skill), are significantly correlated with learning rate criteria (Bravo, Delta, and early graduation), and, although the relation of typing to character learning may be an artifact as discuss above, both are predictive in the regression equations. In all, the most powerful predictors of attrition as well as learning rate performance appear to be two of the musical aptitude measures (timbre, rhythm), the perceptual-memory measures (digit span, digit symbol, perceptual speed), two personality descriptors (introversion-extraversion, Tellegen sustained attention scale), and prior musical training. The variance accounted for is higher when the prediction is to learning rate rather than to course completion. In no case is the predictive power greater than 23%, however (for success in Delta 20 phase - Table 20).

The BARS performance rating scale, used by instructors to indicate their assessment of student capability, shows an instructor capacity to detect who will likely do well in learning

Table 22

Comparison of obtained R2 values for performance criteria for Morse operator and student groups

Group, criterion measure	Significant factors	R2 no demographics	R2 with demo.
Operator SQT	Digit span	.1460	.1452
	Tellegen	.2284	.2234
	Pitch	.2918	.2928
	Typing	--	.3346
Student Bravo 26	Typing	--	.0854
	Perceptual speed	.0729	.1609
	Timbre	.1174	.1971
	Digit span	.1430	--
Student Delta 20	Prior musical instrument	--	.1355
	Introversion/ Extraversion	.1492	.2335
Student Early grad	Digit symbol	.0947	--
	Prior musical instrument	--	.2008
Student Pass/Fail	Rhythm	.0497	.0497
	Digit span	.0817	.0817
	Tellegen	.1136	.1136

the needed Morse skills, but not who will ultimately fail the course. This is similar to the findings of predictive capability from the test instruments.

Concerning differences between the Army and Air Force students, the only factor that emerged was that Air Force students tend to finish Delta phase slightly more quickly than do the Army candidates. No differences are apparent in the attrition rates or early learning of Morse characters. Separate investigations and surveys have been undertaken to further understand the reasons for any interservice differences in performance.

The results from the student group confirm findings from prior studies cited in the background section above. For example, Fleishman's work in the late 1950's indicated that certain musical aptitude and perceptual tests could reliably predict the learning of Morse characters, and time needed to learn certain groupings and speeds. However, the later studies of the 1960's and 1970's (e.g. Helme and Dubuisson, 1962; Pearson and Kasporenko, 1978; Wyant and Creel, 1982;) which tried to relate certain basic psychological skill and aptitude test scores to pass rates, found that motivation, attitudes, and other nonacademic factors played a larger role in the attrition equation. A similar phenomenon has emerged in the current study.

What the findings indicate is that the criterion of most interest, AIT pass or fail, is not a simple measure of capability to learn and transcribe Morse code. If the test instruments selected had accounted for a larger percentage of the variance, (50% or more), then it could be concluded that many current students lack the aptitudes and skills surfaced by the tests. Since there is little relation (11%) to the course success criterion, it is clear that reasons for attrition are not a pure function of capacity to learn the Morse skills.

A question arises as to how the test instruments used in this effort compare to other predictors in current use, namely the designated subscales of the ASVAB (Armed Services Vocational Aptitude Battery) which are prerequisite to 05H AIT. Tables 23 and 24 depict results of stepwise regression analyses for the operator and student samples, respectively (using obtained ASVAB scores as available from the enlisted master file (EMF), or student personnel jackets). For each table, the zero-order correlation, multiple R, R2, and step increase in R values for each model are presented. In this case the forward regression model was used to force in the ASVAB scores first, followed by the new tests that had shown significant prediction for the criterion under consideration. The criterion for inclusion in the regression model was adjusted to $p < .99$ to force in all variables and allow review of the exact contribution of each. In some cases this caused some shifting of the order of the variables due to the nature of the software program.

The data for the operator group (Table 23) indicates that, in combination, the currently used AA(ST scientific technical) and A-P (audio-perceptual) scores from ASVAB and the exploratory test instruments, (Tellegen, pitch, digit span), extend prediction of the field performance criterion (SQT) to 68%, accounting for over two-thirds of the variance. This must be viewed with some caution, since the inclusion of A-P scores available from the EMF on the operator group reduced the sample size to N=26, a questionable number for confidence in interpretation. The proposed new ASVAB composite CL (Clerical), from the Project A studies, appears to add very little to the predictive model.

Table 24 presents the results of the regression equation for the student group including the current and proposed ASVAB measures. Measures from student records could only be obtained for the Army individuals, reducing the group size to N=59. Here it can be seen that ST, AP, and CL combined add less than 1% (.007 to R2) to the existing 11% accounted for by the exploratory test instruments (rhythm, digit span, Tellegen). The selected new instruments are more efficient in predicting the AIT pass/fail criterion, although their overall predictive power is quite low. Again the results are interpreted with caution due to reduced sample size.

The inclusion of the ASVAB variables into the regression equations for the operator and student groups provides some compelling results. For the operator group (those who have already met the criterion of AIT success), the existing and new test measures provide a powerful prediction capability to show who is best at the Morse code task in the field. These same variables, add nothing (as was previously suspected by USAISD) to discriminate success in AIT.

Conclusions

This exploratory study of 05H (Morse Intercept Operator) performance has proceeded by first, identifying characteristics which describe successful performers on the job, and second, matching existing standardized tests to the characteristics in order to determine the relationship, if any, to MOS performance. A secondary question was whether Army and Air Force student candidates displayed differing capabilities in learning and course completion. The only emergent Army/Air Force difference was a slightly more rapid learning rate for Air Force graduates, but no difference in whether a candidate would be successful in course completion or not.

Applying the identified new tests to both operators in the field and students in the Morse AIT base, test scores were entered into predictive equations for criterion performance. For the operator group, recent SQT scores were used as performance criteria, and for the student group, learning rate as well as individual pass or fail data from AIT were collected.

Table 23

Summary of Stepwise Regression Analyses for Morse Operator performance using 12 new test instruments and current predictor (AA-ST, CL, and A-P from ASVAB)

Criterion	Tests	Zero Order r	Multiple R	R2	Increase in R
SQT	A-P	.6028*	.6028*	.3636	.6028
	AA (ST)	.4612*	.7083*	.5019	.1055
	Tellegen	-.3616*	.7982*	.6372	.0899
	CL	.0664	.8184	.6698	.0202
	Pitch	.3038*	.8292	.6876	.0108
	Digit Span	.3821*	.8292	.6877	.0000

* Significant at .01 level of confidence

Table 24

Summary of Stepwise Regression Analyses for Morse AIT student performance using 12 new test instruments and current predictor (AA-ST, CL, and A-P from ASVAB)

Criterion	Tests	Zero Order r	Multiple R	R2	Increase in R
Pass/Fail	Digit Span	.2195*	.2195*	.0782	.2195
	Tellegen	-.1772	.3417	.1168	.1222
	Rhythm	.2229*	.3595	.1293	.0178
	CL	.0854	.3635	.1322	.0040
	AA(ST)	-.0089	.3683	.1357	.0048
	A-P	.0918	.3702	.1371	.0019

* Significant at .05 level of confidence

The pie chart at the top of Figure 7 graphically depicts the amount of predictive power to the field performance criterion (SQT) for the operator group, using existing measures (AA-ST, AP, CL), as well as the new tests. The chart at the bottom of Figure 7 shows the predictive capability of the current ASVAB and new tests for the criterion of AIT attrition in the student group. A comparison between the two is striking. While the existing and new measures account for over two-thirds (68%) of success in the field, the same measures only account for just over one-tenth (11.01%) of what contributes to AIT course completion.

As indicated in the discussion of findings above, the new tests are more effective for predicting certain learning rate criteria (time to Bravo 26, time to Delta 20, potential for early course completion). This may be useful in identifying who will ultimately be proficient on the job, but not who will succeed through AIT. Obviously passing AIT is not as closely related to pure Morse code skill acquisition as had been hoped. Since the new tests did relate to the skill acquisition criteria (Bravo 26, Delta 20, early graduation), the lack of significant relation to pass/fail means that this criterion is contaminated by other unknown factors. Until these factors are identified, predictors of AIT success cannot be developed.

Phase III of this effort was projected to conduct psychometric cross validation studies of the new test measures for possible selection use, if warranted. It is clear from the above findings that, although some of these new measures have shown a relation to on the job performance for this MOS, and thus show some promise to complement existing predictors, AIT attrition is largely unaccounted for by the selection process. Rather than pursue the refinement and cross validation of the new measures at this time, a more meaningful and cost effective pursuit would be to systematically identify the primary attrition factors in the AIT learning process and environment, and adjust training and selection strategies accordingly. What this entails is a further definition of attrition factors pertinent to the training experience, and an in-depth examination of the learning process as each stage of the skill is acquired, to determine where difficulties occur. These recommendations have been proposed and accepted as the next phase of ARI research for USAISD in the morse operator proficiency area.

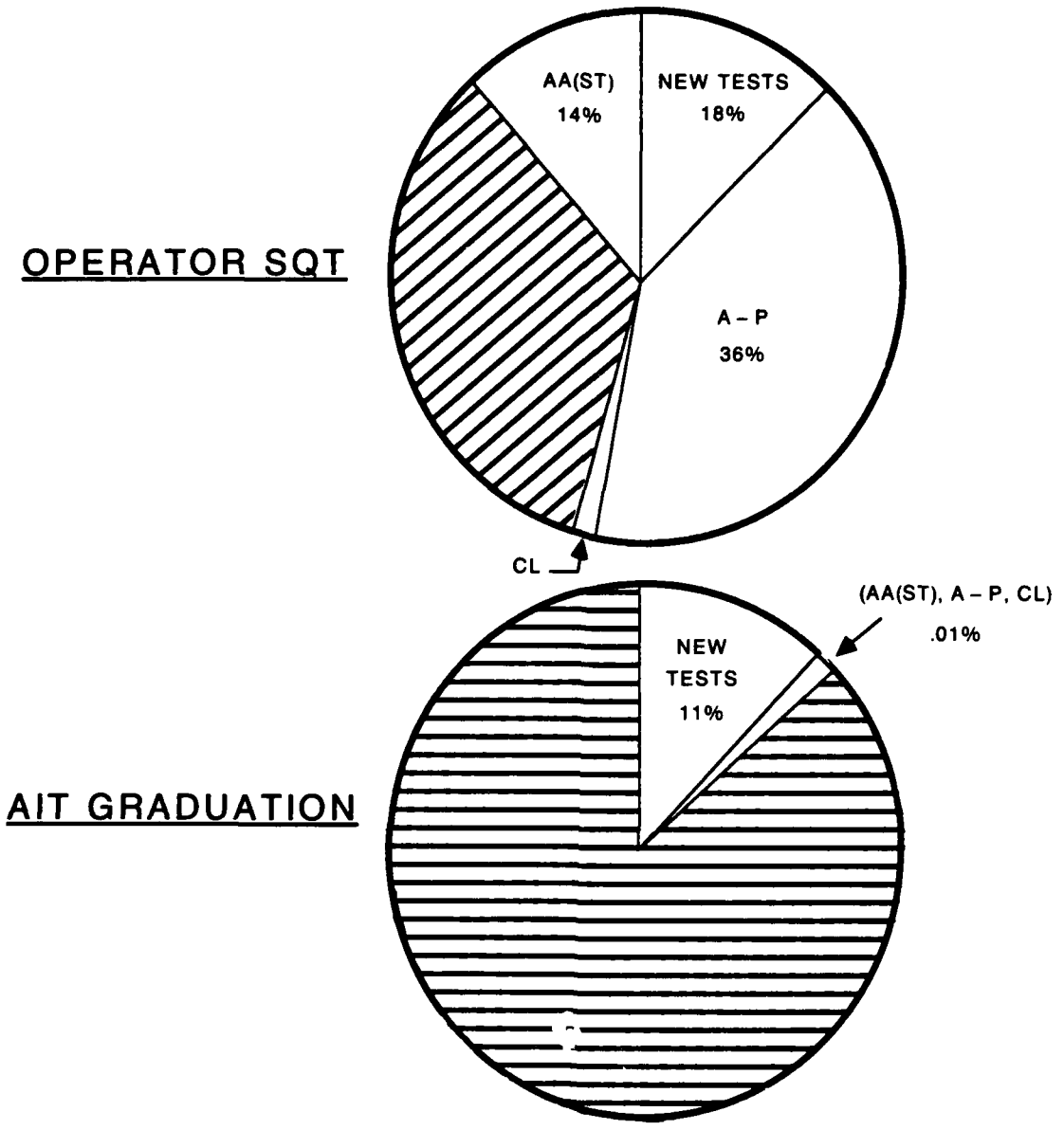

Figure 7. Graphical representation of prediction of Morse Operator performance (SQT) vice Morse AIT student performance (pass/fail).

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APPENDIX A

Rationale for tests selected for use in the 05H attrition study

The following discussion provides the rationale and background of the tests selected for exploratory use measuring the elicited Morse code operator characteristics (listed in Table 3 of the text).

Musical ability measures. A musical ability measure was selected because a sense of rhythm and ability to distinguish tones similar to musical notes were mentioned by all subject matter experts interviewed, and in psychological literature (Keller 1943, 1958). The test chosen was the Seashore Measures of Musical Talent (Seashore, 1938). This measures both musical ability and musical aptitude along six scales, and the test has been widely used with extensive reliability and validity correlations and population norms developed over the last 50 years. The six subscales within the instrument are: pitch- discrimination of high and low tones, loudness- discrimination of tonal intensity, time- discrimination of tonal durations, timbre-discrimintation of tonal qualities, rhythm- memory of tonal patterns, and tonal memory- identification of changed notes within a series. These six dimensions are widely accepted as covering the full spectrum of musical aptitude and skill.

Short-term memory and perceptual measures. Two short-term memory measures and a perceptual memory measure were selected to quantify the stages of Morse code processing involving very short term memory storage, associative ability (perceptual processing to motor output translation), and speed of percept identification.

The short term memory measure used was the Digit Span subtest (12-digit immediate recall) from the WAIS (Wechsler Adult Intelligence Scale, Wechsler, 1958). This is a well documented component of general intelligence with all age group normative data available, and has been widely used as an index of working memory (Baddely and Lewis, 1984; Reisberg, Rappaport, and O'Shaugnessy, 1984). It is also believed to reflect the ability to retain information about the order of a sequence of events (Martin, 1978). The test is easy to administer and score.

For associative ability and performance, the Digit Symbol Substitution Test, also a subtest from the WAIS, was selected. The DST requires individuals to match an abstract symbol to a specified number (0-9) within a 90 second time period. It has been widely used as a measure of associative ability and performance (McLeod, Griffiths, Bigelow, & Yingling, 1982). This test, also well validated with all age groups, was considered a paper and pencil analog of the signal identification and keyboard output tasks required in code transcription. Of particular importance is the fact that it is done under time pressure and

requires translation of information from an input sense modality to a translation for motor output, just as in Morse transcription.

The perceptual speed measure selected was the perceptual speed test from the kit of cognitive factor referenced tests (French, Ekstrom, & Price, 1976). This requires individuals to distinguish between same and different number number pairs of various lengths within a 90 second time period. The test was specifically developed along with the many others in this series, to relate to a specific cognitive factor, in this case three subfactors: decision speed, perceptual memory, and perceptual readiness. All of these components were clearly described as critical to the Morse task, which involves rapid search through sensory-perceptual buffers which are storing the immediate data, a perceptual decision on that data, and a template of symbol meanings brought to bear on the data. The overall factor is said to be related to the development of an "automatic process" (Kunnapas, 1969), exactly what is needed to interpret code when input speed exceeds immediate processing.

Personality measures. Three personality dimensions were measured for this pilot effort: introversion-extraversion, neuroticism-stability, and sustained attention capacity or absortion. All of these were clearly mentioned in the subject matter expert focus groups. The typical successful Morse code professional was said to be extraverted, very stable, and having a capacity to "block out the world", that is concentrate on one input stream to the exclusion of other competing stimuli.

The classic measure of introversion-extraversion was chosen based on the work by Eysenck (1947). The Eysenck personality inventory contains the I-E dimension as well as neuroticism-stability items. This 40 item true-false checklist has been widely and efficiently used for over 30 years and has resulted in reams of valid and reliable data relating to the cognitive underpinnings of the I-E dimension. An individual who is extraverted is said to be outgoing, uninhibited, cautious, and sociable. An introverted individual is opposite to this. The test output yields as scale wherein the "average" adult falls in the middle, a complement of both attributes, and selected subpopulations are more or less predominantly one or the other. It was strongly mentioned that Morse code operators were extraverted. The stability scale simply indicates any tendency away from a norm of social flexibility and coping skills toward and overreponsiveness to stress. It was felt that successful operators would show little neurotic tendency and be in a normal stable range. The Eysenck inventory is very easily administered and scored and compared to extensive adult group norms.

The final measure selected was an exploratory scale developed by the innovative cognitive research scientist Auke Tellegen. His Q3 self-report questionnaire was assembled from various research studies (Lee, 1963; Lee-Teng, 1965; Shor, 1960; and As, O'Hara, &

Munger, 1962) relating to hypnotic susceptibility. The development of the scales in five content areas (absorption, dissociation, trust, impulsiveness, and relaxation) was motivated by the fact that scales from the major personality inventories (California Personality Inventory, 16 Personality Factor Scale, Gulford-Zimmerman, Minnesota Multiphasic Personality Inventory, Maudsley Personality Inventory) failed to show consistent relations to hypnotic susceptibility, and in fact seemed to be primarily differentiations of the two major dimensions of introversion-extraversion and neuroticism-stability, as elaborated by Eysenck and others (1947). Of particular interest in the Q3 inventory of Tellegen was the absorption subscale, which appeared to capture the quality mentioned by many Morse code subject matter experts as an ability to "block out the world", to focus on specific signals among noise, both transmission noise and unrelated ongoing activity noise. Since Tellegen had done extensive work in validity areas with the Q3, permission was obtained to apply the absorption subscale in this exploratory study. In fact, the simply administered checklist has extensive adult norms from Tellegen's work, classified by female, male, and combined groupings. The hypothesis was that successful Morse operators and students would score in the category of high susceptibility to absorption, showing a keen capacity to sustain attention on one stimulus source in the face of competing others.

Demographic features. The remaining factor mentioned in the list of consolidated Morse characteristics, geographical background, was simply gathered by checklist on the demographic cover sheet provided each individual. The notion was that the more suburban to rural an individual's background, the easier the learning and subsequent job performance processes. Since a city type environment provides a stimulus overload incompatible with the more placid, routine experiences elsewhere, and Morse code perception, interpretation, and transcription requires patience, persistence, and attention to repetitious detail, it was felt that those from a rural background would have more success in tolerating the code operator's demands.

APPENDIX B

Demographic Fact Sheet - Morse Code Operators

1. Total number of years in military service?

   A) < 1 year
   B) 1-3 years
   C) 4-7 years
   D) 7 or more years

2. Age: _____; Indicate range below:

   A) 18-20
   B) 21-23
   C) 24-26
   D) 27-29
   E) 30-32
   F) 33-35
   G) 36 or older

3. Sex:

   A) Male
   B) Female

4. Marital Status

   A) Single
   B) Married
   C) Separated
   D) Divorced
   E) Widowed

5. Indicate the type of area you are from:

   A) Urban
   B) Suburban
   C) Rural

6. Education: Please indicate highest completed educational level.

   A) High School
   B) College
   C) Masters
   D) Doctoral
   E) Post-Doctoral

7. Previous Occupation (before entry into military service).

   A) Student (i.e. college)

B) Food Service (i.e. waitress, cook, busboy, cashier)
C) Sales (i.e. retail, salesperson)
D) Manual/Blue Collar (i.e. laborer, construction worker)
E) General Technical (i.e. computer programmer, police officer)
F) Technical/Mechanical (i.e. camera technician, auto mechanic, machinist)
G) Technical Verbal (i.e. journalist, teacher)
I) Administrative (i.e. office manager, legal assistant)
J) Other: Please specify

8. Have you held any other military specialities?

A) Yes
B) No

If answer is yes, please indicate previous military specialities:

NUMBER & TITLE NUMBER OF MONTHS

1._____

2._____

3._____

4._____

5._____

9. Do you have any prior typing experience?

A) Yes
B) No

10. Do you have any prior Morse code training or experience?

A) Yes
B) No

11. Do you play a musical instrument?

A) Yes
B) No

APPENDIX C

Supervisor Rating Scale for Morse Code Operators

05H SUPERVISOR SURVEY

TECHNICAL KNOWLEDGE/SKILL:

How effective is each operator in displaying job knowledge/skill?

	Does not display the knowledge/skill required to perform many job assignments and tasks.		Displays the knowledge/ skill required to perform most job assignments and tasks properly, but may need help for harder tasks			Displays the knowledge/skill to perform all job assignments and tasks properly.	
1	1	2	3	4	5	6	7
2	1	2	3	4	5	6	7
3	1	2	3	4	5	6	7
4	1	2	3	4	5	6	7
5	1	2	3	4	5	6	7
6	1	2	3	4	5	6	7
7	1	2	3	4	5	6	7
8	1	2	3	4	5	6	7
9	1	2	3	4	5	6	7
10	1	2	3	4	5	6	7
11	1	2	3	4	5	6	7
12	1	2	3	4	5	6	7
13	1	2	3	4	5	6	7
14	1	2	3	4	5	6	7
15	1	2	3	4	5	6	7

EFFORT:

How effective is each operator in showing extra effort on the job?

	Does not put in the effort to make sure the job gets done; may give up easily when faced with difficult problems or situations.		Puts in the extra effort and keeps trying when it's very important to complete assignments; overcomes obstacles/adversities on the job, in garrison, and in the field.			Often volunteers to work extra hours pushes on to overcome all difficulties and adversities until the job is done.	
1	1	2	3	4	5	6	7
2	1	2	3	4	5	6	7
3	1	2	3	4	5	6	7
4	1	2	3	4	5	6	7
5	1	2	3	4	5	6	7
6	1	2	3	4	5	6	7
7	1	2	3	4	5	6	7
8	1	2	3	4	5	6	7
9	1	2	3	4	5	6	7
10	1	2	3	4	5	6	7
11	1	2	3	4	5	6	7
12	1	2	3	4	5	6	7
13	1	2	3	4	5	6	7
14	1	2	3	4	5	6	7
15	1	2	3	4	5	6	7

FOLLOWING REGULATIONS AND ORDERS:

How effective is each operator in adhering to regulations, orders, and SOP and displaying respect for superiors?

	Often fails to follow Army/unit rules, regulations, or orders; may show disrespect toward superiors.		Almost always follows Army/unit rules and regulations; always obeys orders.			Carefully follows the spirit and letter of Army/unit rules and regulations; obeys orders quickly and with enthusiasm.	
1	1	2	3	4	5	6	7
2	1	2	3	4	5	6	7
3	1	2	3	4	5	6	7
4	1	2	3	4	5	6	7
5	1	2	3	4	5	6	7
6	1	2	3	4	5	6	7
7	1	2	3	4	5	6	7
8	1	2	3	4	5	6	7
9	1	2	3	4	5	6	7
10	1	2	3	4	5	6	7
11	1	2	3	4	5	6	7
12	1	2	3	4	5	6	7
13	1	2	3	4	5	6	7
14	1	2	3	4	5	6	7
15	1	2	3	4	5	6	7

INTEGRITY:

How effective is each operator in displaying honesty and integrity in job-related and personal matters?

	Makes up excuses to avoid duty/ assignments; fails to take responsibility for any job-related mistakes; may be untruthful about job or personal matters.		Admits and takes responibility for most job-related mistakes he/she makes; is truthful questioned about job or personal matters.			Takes extra steps to ensure that others are not blamed for his/her mistakes; is always honest, even when it may go against personal interests.	
1	1	2	3	4	5	6	7
2	1	2	3	4	5	6	7
3	1	2	3	4	5	6	7
4	1	2	3	4	5	6	7
5	1	2	3	4	5	6	7
6	1	2	3	4	5	6	7
7	1	2	3	4	5	6	7
8	1	2	3	4	5	6	7
9	1	2	3	4	5	6	7
10	1	2	3	4	5	6	7
11	1	2	3	4	5	6	7
12	1	2	3	4	5	6	7
13	1	2	3	4	5	6	7
14	1	2	3	4	5	6	7
15	1	2	3	4	5	6	7

LEADERSHIP:

How effective is each operator in performing in a leader role, as required, and providing guidance for fellow unit members?

	Fail to take charge when leadership is required in unit; provides no guidance to other unit members on tasks, assignments, etc., even when it's necessary to do so.		Performs well in leadership situations where expected is well known; when asked, guides others through some tasks, assignments, etc.			Takes charge when necessary to lead the unit; fills in effectively when NCO is absent by skillfully leading unit, guiding unit members through tasks or assignments, etc.	
1	1	2	3	4	5	6	7
2	1	2	3	4	5	6	7
3	1	2	3	4	5	6	7
4	1	2	3	4	5	6	7
5	1	2	3	4	5	6	7
6	1	2	3	4	5	6	7
7	1	2	3	4	5	6	7
8	1	2	3	4	5	6	7
9	1	2	3	4	5	6	7
10	1	2	3	4	5	6	7
11	1	2	3	4	5	6	7
12	1	2	3	4	5	6	7
13	1	2	3	4	5	6	7
14	1	2	3	4	5	6	7
15	1	2	3	4	5	6	7

MAINTAINING ASSIGNED EQUIPMENT:

How effective is each operator in checking on and maintaining own weapon/vehicle/other equipment?

	Keeps assigned equipment in poor condition by failing to perform or improperly performing checks and preventive maintenance.		Keeps assigned equipment in good condition by performing routine checks and preventive maintenance; notes and corrects major deficiencies.			Keeps assigned equipment in ready-for-inspection condition by performing appropriate checks and preventive maintenance, noting and correcting all deficiencies.	
1	1	2	3	4	5	6	7
2	1	2	3	4	5	6	7
3	1	2	3	4	5	6	7
4	1	2	3	4	5	6	7
5	1	2	3	4	5	6	7
6	1	2	3	4	5	6	7
7	1	2	3	4	5	6	7
8	1	2	3	4	5	6	7
9	1	2	3	4	5	6	7
10	1	2	3	4	5	6	7
11	1	2	3	4	5	6	7
12	1	2	3	4	5	6	7
13	1	2	3	4	5	6	7
14	1	2	3	4	5	6	7
15	1	2	3	4	5	6	7

SELF-DEVELOPMENT:

How effective is each operator in developing own job skills?

	Does not try to improve job skills by studing, practicing, or participating in courses or training.		Practices, studies manuals, or participates in courses/training to improve job skills as required.			Studies, works hard during off-duty time, seeks out education or training, or additional job duties/responsibilities to improve job skills as much as possible.	
1	1	2	3	4	5	6	7
2	1	2	3	4	5	6	7
3	1	2	3	4	5	6	7
4	1	2	3	4	5	6	7
5	1	2	3	4	5	6	7
6	1	2	3	4	5	6	7
7	1	2	3	4	5	6	7
8	1	2	3	4	5	6	7
9	1	2	3	4	5	6	7
10	1	2	3	4	5	6	7
11	1	2	3	4	5	6	7
12	1	2	3	4	5	6	7
13	1	2	3	4	5	6	7
14	1	2	3	4	5	6	7
15	1	2	3	4	5	6	7

SELF-CONTROL:

How effective is each operator in controlling own behavior related to aggresive acts?

	Often cannot control own behavior; loses temper easily.			Keeps even temper in most situations.		Always keeps a cool head and avoids aggressive acts.	
1	1	2	3	4	5	6	7
2	1	2	3	4	5	6	7
3	1	2	3	4	5	6	7
4	1	2	3	4	5	6	7
5	1	2	3	4	5	6	7
6	1	2	3	4	5	6	7
7	1	2	3	4	5	6	7
8	1	2	3	4	5	6	7
9	1	2	3	4	5	6	7
10	1	2	3	4	5	6	7
11	1	2	3	4	5	6	7
12	1	2	3	4	5	6	7
13	1	2	3	4	5	6	7
14	1	2	3	4	5	6	7
15	1	2	3	4	5	6	7

ATTENDANCE:

How effective is each operator at reporting to the job on time and performing attentively?

	Is often late for "skeds"; makes frequent trips to the latrine; sometimes "sleeps" on the job.		Is usually on time for "skeds"; rarely "sleeps" on the job; infrequently schedules medical appointments during duty hours.			Is always on time for "skeds" and rarely absent for medical reasons; always attentive on the job.	
1	1	2	3	4	5	6	7
2	1	2	3	4	5	6	7
3	1	2	3	4	5	6	7
4	1	2	3	4	5	6	7
5	1	2	3	4	5	6	7
6	1	2	3	4	5	6	7
7	1	2	3	4	5	6	7
8	1	2	3	4	5	6	7
9	1	2	3	4	5	6	7
10	1	2	3	4	5	6	7
11	1	2	3	4	5	6	7
12	1	2	3	4	5	6	7
13	1	2	3	4	5	6	7
14	1	2	3	4	5	6	7
15	1	2	3	4	5	6	7

ADMINISTRATIVE DUTIES:

How effective is each operator at completing forms and logs, and writing reports?

	Often intercept forms and logs, and written reports need to be altered by a supervisor; doesn't facilitate follow-up processing and analysis.		Completes intercept forms and logs, and reports with few errors; helps in facilitating follow-up processing and analysis.			Promptly completes intercept forms and logs, and reports without errors; often initiates the recording of data entries facilitating follow-up processing and analysis.	
1	1	2	3	4	5	6	7
2	1	2	3	4	5	6	7
3	1	2	3	4	5	6	7
4	1	2	3	4	5	6	7
5	1	2	3	4	5	6	7
6	1	2	3	4	5	6	7
7	1	2	3	4	5	6	7
8	1	2	3	4	5	6	7
9	1	2	3	4	5	6	7
10	1	2	3	4	5	6	7
11	1	2	3	4	5	6	7
12	1	2	3	4	5	6	7
13	1	2	3	4	5	6	7
14	1	2	3	4	5	6	7
15	1	2	3	4	5	6	7

DATA ANALYSIS:

How effective is each operator in performing analysis?

	Often fails to notice irregularities of interest in performing the collector analysis; makes many computer generated errors that can be attributed to the operator.		Performs collector analysis adequately, often noticing suspect items of intelligence interest; makes few computer generated errors that can be attributed to the operator.			Completes collector analysis efficiently always noticing and promptly reporting suspect items of intelligence interest; rarely makes a computer generated error.	
1	1	2	3	4	5	6	7
2	1	2	3	4	5	6	7
3	1	2	3	4	5	6	7
4	1	2	3	4	5	6	7
5	1	2	3	4	5	6	7
6	1	2	3	4	5	6	7
7	1	2	3	4	5	6	7
8	1	2	3	4	5	6	7
9	1	2	3	4	5	6	7
10	1	2	3	4	5	6	7
11	1	2	3	4	5	6	7
12	1	2	3	4	5	6	7
13	1	2	3	4	5	6	7
14	1	2	3	4	5	6	7
15	1	2	3	4	5	6	7

OPERATIONS:

How effective is each operator in performing job operations duties?

	Often displays borderline (poor) performance standards for detecting, acquiring identifying, and recording foreign communications.		Almost always displays average/good performance in detecting, acquiring, identifying, and recording foreign communications.			Maintains excellent performance in detecting, acquiring identifying, and recording foreign communications; seems to have a natural "talent".	
1	1	2	3	4	5	6	7
2	1	2	3	4	5	6	7
3	1	2	3	4	5	6	7
4	1	2	3	4	5	6	7
5	1	2	3	4	5	6	7
6	1	2	3	4	5	6	7
7	1	2	3	4	5	6	7
8	1	2	3	4	5	6	7
9	1	2	3	4	5	6	7
10	1	2	3	4	5	6	7
11	1	2	3	4	5	6	7
12	1	2	3	4	5	6	7
13	1	2	3	4	5	6	7
14	1	2	3	4	5	6	7
15	1	2	3	4	5	6	7

OVERALL EFFECTIVENESS RANKINGS:

Please rank order all of your operators from highest to lowest (with 1 representing the highest ranking) on their overall effectiveness, considering the above 12 dimensions.

1 ___

2 ___

3 ___

4 ___

5 ___

6 ___

7 ___

8 ___

9 ___

10 ___

11 ___

12 ___

13 ___

14 ___

15 ___

OVERALL EFFECTIVENESS RATINGS:

How does each of your operators individually rate on overall effectiveness, considering the above 12 dimensions?

	Performs poorly in important effectiveness areas; does not meet standards and expectations for adequate performance		Adequately performs in important effectiveness areas; meets standards and expectations for adequate performance.			Performs excellently in all or almost all effectiveness areas -exceeds standards and expectations for performance.	
1	1	2	3	4	5	6	7
2	1	2	3	4	5	6	7
3	1	2	3	4	5	6	7
4	1	2	3	4	5	6	7
5	1	2	3	4	5	6	7
6	1	2	3	4	5	6	7
7	1	2	3	4	5	6	7
8	1	2	3	4	5	6	7
9	1	2	3	4	5	6	7
10	1	2	3	4	5	6	7
11	1	2	3	4	5	6	7
12	1	2	3	4	5	6	7
13	1	2	3	4	5	6	7
14	1	2	3	4	5	6	7
15	1	2	3	4	5	6	7

CONFIDENCE RATING:

For each operator, please indicate how confident you are with the effectiveness ratings that you just completed?

	not at all confident		moderately confident			very confident	
1	1	2	3	4	5	6	7
2	1	2	3	4	5	6	7
3	1	2	3	4	5	6	7
4	1	2	3	4	5	6	7
5	1	2	3	4	5	6	7
6	1	2	3	4	5	6	7
7	1	2	3	4	5	6	7
8	1	2	3	4	5	6	7
9	1	2	3	4	5	6	7
10	1	2	3	4	5	6	7
11	1	2	3	4	5	6	7
12	1	2	3	4	5	6	7
13	1	2	3	4	5	6	7
14	1	2	3	4	5	6	7
15	1	2	3	4	5	6	7

APPENDIX D

Demographic Fact Sheet - Morse Code Students

1. Total number of years in military service?

   A) < 1 year
   B) 1-3 years
   C) 4-7 years
   D) 7 or more years

2. Age: _____; Indicate range below:

   A) 18-20
   B) 21-23
   C) 24-26
   D) 27-29
   E) 30-32
   F) 33-35
   G) 36 or older

3. Sex:

   A) Male
   B) Female

4. Marital Status

   A) Single
   B) Married
   C) Separated
   D) Divorced
   E) Widowed

5. Indicate the type of area you are from:

   A) Urban
   B) Suburban
   C) Rural

6. Education: Please indicate highest completed educational level.

   A) High School
   B) College
   C) Masters
   D) Doctoral
   E) Post-Doctoral

7. Previous Occupation (before entry into military service).

   A) Student (i.e. college)

B) Food Service (i.e. waitress, cook, busboy, cashier)
C) Sales (i.e. retail, salesperson)
D) Manual/Blue Collar (i.e. laborer, construction worker)
E) General Technical (i.e. computer programmer, police officer)
F) Technical/Mechanical (i.e. camera technician, auto mechanic, machinist)
G) Technical Verbal (i.e. journalist, teacher)
I) Administrative (i.e. office manager, legal assistant)
J) Other: Please specify

8. Have you held any other military specialities?

A) Yes
B) No

If answer is yes, please indicate previous military specialities:

NUMBER & TITLE NUMBER OF MONTHS

1._____

2._____

3._____

4._____

5._____

9. Do you have any prior typing experience?

A) Yes
B) No

10. Do you have any prior Morse code training or experience?

A) Yes
B) No

11. Do you play a musical instrument?

A) Yes
B) No

APPENDIX E

Instructor Rating Scale for Morse Code Students

O5H Instructor Survey

Instructor's Name:_____
Student's Name:_____

PERFORMANCE IN TRAINING:

*Student maintains a consistent code copy rate throughout a day (ie. consistent passing or failing rate).

Almost Never 1 2 3 4 5 Almost Always

*Student maintains a consistent code copy rate throughout the course (over numerous weeks).

Almost Never 1 2 3 4 5 Almost Always

*Student copies 100% of all messages sent (regardless of errors).

Almost Never 1 2 3 4 5 Almost Always

*Student diligently copies code a greater percentage of the hour relative to the other students.

Almost Never 1 2 3 4 5 Almost Always

MOTIVATION/SELF-DISCIPLINE:

*Student takes responsibility for his/her own performance (ie. does not "give up" or make excuses for poor performance).

Almost Never 1 2 3 4 5 Almost Always

*Student is present for class and on time each day.

Almost Never 1 2 3 4 5 Almost Always

*Student monitors his/her course progress (ie. inspects hourly roster of scores posted; asks instructor).

Almost Never 1 2 3 4 5 Almost Always

*Student seems to provide his/her own motivation - either a positive "pat on back" or negative kick in pants" (ie. does not require the instructor's motivation).

Almost Never 1 2 3 4 5 Almost Always

ATTENTION/EFFORT:

*Student is attentive toward the instructor (ie. establishes eye contact; asks questions).

Almost Never 1 2 3 4 5 Almost Always

*Student reads and follows instructions (ie. consistently from the start of the course; takes 2-3 weeks to realize the importance of of instructions).

Almost Never 1 2 3 4 5 Almost Always

*Student is attentive toward the task at hand (ie. hunches determinedly over the keyboard while copying code; slouches back in a relaxed, unhurried position).

Almost Never 1 2 3 4 5 Almost Always

*Student displays effort to do well in the course (ie. seeks assistance/feedback from the instructor to improve performance).

Almost Never 1 2 3 4 5 Almost Always

SOCIAL BEHAVIOR:

*Student engages in social activities with his/her peers outside the classroom (ie. travels downtown on weekends; engages in sports, hobbies; or is a "barrack rat").

Almost Never 1 2 3 4 5 Almost Always

*Student engages in thrill-seeking, outrageous behavior inside or outside the classroom (ie. "practical jokes" requiring disciplinary action, etc.).

Almost Never 1 2 3 4 5 Almost Always